tron is entirely electro-magnetic. Any such statement virtually assumes a particular distribution of the electricity in a spherical electron of given size. But if electricity itself really consists of electrons, an argument of this type would appear to be so perfectly circular that it is questionable how much weight should be attached to it. If the equivalent mass of an electron in motion arises slowly from the electromagnetic field produced by its motion, a neutral corpuscle of caloric should not possess mass or energy of translation as a whole, though it might still possess energy of vibration or rotation of its separate charges. For the purpose of mental imagery we might picture the electron as the free or broken end of a vortex filament, and the neutral corpuscle as a vortex ring produced when the positive and negative ends are united; but a mental picture of this kind does not carry us any further than the sphere coated with electricity, except in so far as either image may suggest points for experimental investigation. In our ignorance of the exact mechanism of gravity it is even conceivable that a particle of caloric might possess mass without possessing weight, though, with the possible exception of the electron, nothing of the kind has yet been demonstrated. In any case it would appear that the mass, if any, associated with a quantity of caloric must be so small that we could not hope to learn much about it by the direct use of the balance.

The fundamental property of caloric, that its total quantity cannot be diminished by any known process and that it is not energy but merely the vehicle or carrier of energy, is most simply represented in thought by imagining it to consist of some indestructible form of matter. The further property, that it is always generated in any turbulent or irreversible process, appears at first sight to conflict with this idea, because it is difficult to see how anything indestructible can be so easily generated. When, however, we speak of caloric as being generated, what we really mean is that it becomes associated with a material body in such a way that we can observe and measure its quantity by the change of state produced. The caloric may have existed previously in a form in which its presence could not be detected. In the light of recent discoveries we might suppose the caloric generated to arise from the disintegration of the atoms of matter. No doubt some caloric is produced in this way, but those corpuscles that are so strongly held as to be incapable of detection by ordinary physical methods require intense shocks to dislodge them. A more probable source of caloric is the æther, which, so far as we know, may consist entirely of neutral corpuscles of caloric. The hypothesis of a continuous æther has led to great difficulties in the electromagnetic theory of light and in the kinetic theory of gases. A molecular, or cellular-vortex, structure appears to be required. According to the researches of Kelvin, Fitzgerald, and Hicks, such an æther can be devised to satisfy the requirements of the electromagnetic theory without requiring it to possess a density many times greater than that of platinum. So far as the properties of caloric are concerned, a neutral pair of electrons would appear to constitute the simplest type of molecule, though without more exact knowledge of the ultimate nature of an electric charge it would be impossible to predict all its properties. Whether an æther composed of such molecules would be competent to discharge satisfactorily all the onerous functions expected from it, may be difficult to decide, but the inquiry, in its turn, would probably throw light on the ultimate structure of the molecule.

Without venturing too far into the regions of metaphysical speculation, or reasoning in vicious circles about the nature of an electric charge, we may at least assert with some degree of plausibility that material bodies under ordinary conditions probably contain a number of discrete physical entities, similar in kind to X rays or neutral corpuscles, which are capable of acting as carriers of energy, and of preserving the statical equilibrium between matter and radiation at any temperature in virtue of their interchanges with electrons. If we go a step further and identify these corpuscles with the molecules of caloric, we shall certainly come in conflict with some of the fundamental dogmas of the kinetic theory, which tries to express everything in terms of energy, but the change involved is mainly one of point of view or expression. The experimental facts remain the same, but we describe them differently. Caloric has a physical existence, instead of being merely the logarithm of the probability of a complex ion. In common with many experimentalists, I cannot help feeling that we have everything to gain by attaching a material conception to a quantity of caloric as the natural measure of a quantity of heat as opposed to a quantity of heat energy. In the time at my disposal I could not pretend to offer you more than a suggestion of a sketch, an apology for the possibility of an explanation, but I hope I may have succeeded in conveying the impression that a caloric theory of heat is not so entirely unreasonable in the light of recent experiment as we are sometimes led to imagine.

NOTES.

DR. G. T. BEILBY, F.R.S., has been appointed a member of the Royal Commission on Oil Fuel in succession to the late Dr. H. Owen Jones.

THE death is announced, at eighty years of age, of Prof. T. Gomperz, of the University of Vienna, distinguished by his studies in philology and philosophy, and well known by his work "Greek Thinkers," of which an English translation appeared several years ago.

As previously announced, the autumn meeting of the Institute of Metals will be held in London on Wednesday and Thursday, September 25 and 26. The following are among the papers that are expected to be submitted:—Autogenous welding by means of oxygen and acetylene of copper and its principal alloys, and of aluminium, Prof. F. Carnevali; the effect of other metals on the structure of the beta constituent in copper-zinc alloys, Prof. H. C. H. Carpenter; the effect of temperatures higher than atmospheric on tensile tests of copper and its alloys, Prof. A. K. Huntington; the influence of oxygen on the properties of metals and alloys, E. F. Law; the annealing of coinage alloys, Dr. T. Kirke Rose; intercrystalline cohesion in metals (with an appendix on the formation of twinned crystals in silver), Dr. W. Rosenhain and D. Ewen; oxygen in brass, Prof. T. Turner.

WE regret to announce that Prof. T. Winter, professor of agriculture in University College of North Wales, Bangor, died on Sunday, September 1, at forty-six years of age. Prof. Winter was educated at Darlington Grammar School and Edinburgh University, where he graduated in arts. He afterwards became assistant lecturer on agriculture at the University College of North Wales. Later he was appointed lecturer in agriculture at the University of Leeds; and in 1894 he returned to the University College of North Wales as head of the agricultural department. He took an active part in agricultural matters in Wales, and was widely known and respected throughout the country.

We are glad to see that progress is gradually being made with the synchronisation of clocks, thanks largely to the enterprise of private companies. Last year a committee of the British Science Guild presented a valuable report upon the position of the subject and the system employed by the General Post Office, and an instructive account of synchronisation and the importance of correct time is given by Major O'Meara in an address printed in this year's report of the Guild. The committee recommended that, as a beginning, it would probably be well to have a few large public clocks in London synchronised, and that these should be set apart and considered as "standard time clocks." An electric clock which may be used for the purpose suggested by the committee has just been built by the Silent Electric Clock Co., 192 Goswell Road, London, E.C., on the new mills of the Hovis Bread Co., Vauxhall Bridge Road. We understand that this electric clock, with its four faces each 9 ft. 6 in. diameter, is not only the largest electric clock in London, but is also to be controlled by a master clock directly synchronised from Greenwich. The clock thus represents an up-to-date form of public timekeeper which is likely to be extensively adopted in the future.

A local society which possesses such a creditable record of work as the Royal Cornwall Polytechnic Society does well to commemorate worthies who were members of their body. In the first part of its Proceedings for 1912 it publishes portraits and lives of three of its most eminent members, Sir C. Lemon, F.R.S., first president (1833–67), who did good service to science by his attempt to found a school of mines at Truro, a project which was in advance of the times when it was proposed, but has been since realised; Lord de Dunstanville, first patron, scholar and politician; and last, but not least, Davies Gilbert, who succeeded Sir Humphry Davy as president of the Royal Society, an accomplished botanist and distinguished in other branches of science. In the annual report the council takes occasion to congratulate the Rev. Philip Carlyon, a former vice-president of the society, on attaining the age of a hundred years in December last.

Volume xi. of the Zoological Publications of the Field Museum is devoted to an account of the mammals of Illinois and Wisconsin, comprising 502 pages of text and a large number of illustrations. "Keys" to the various genera and their species are given.

In the report of the Field Museum of Natural History, Chicago, for 1911, the director refers to the acquisition by the trustees of a site for a new building in Jackson Park, immediately to the north of the present structure. The plans for the new building have been approved, and the specifications for the contracts drawn up. The report is illustrated with photographs of bird groups and other interesting exhibits recently added to the museum.

The Meteorological Service of Canada has issued a very useful pamphlet on the comparison of the Ångström pyrheliometer and the Callendar sunshine recorder, and the determination of the proportion of heat received on a horizontal surface from the diffuse radiation from the sky to that received from the sun. The International Union for Cooperation in Solar Research at its Oxford conference recommended (1) the adoption of the former instrument, and (2) comparisons between it and other standard instruments, but except at laboratories and the larger observatories little is yet generally known about its working. The paper in question, prepared by Mr. J. Patterson, under the direction of Mr. R. F. Stupart, gives a very clear idea of the construction and action of both the above instruments. The following are among the noteworthy features shown by their comparison: (1) the maximum intensity of radiation measured by the Ångström instrument occurred at apparent noon, and by the Callendar recorder about forty minutes later. (2) The Ångström instrument gave slightly higher values in the afternoon than in the morning, and the Callendar recorder much higher values. (3) In the early morning and late afternoon the Callendar instrument gave higher readings than the Ångström. (4) Excluding the morning readings the greatest percentage difference occurred between 9h. and 10h. a.m.; from about 1h. to 3h. p.m. the change in percentage was very slight.

Sir T. L. Heath has now supplied an English edition (Cambridge Press, *2s. 6d.*) of the "Method" of Archimedes, discovered by Heiberg in 1906. This tract is of very great interest, because it gives mechanical discussions of geometrical problems based upon the principle of the lever. Thus we have the rule for the quadrature of a parabolic segment, which Archimedes elsewhere proves by the method of exhaustion. Archimedes expressly says that the "Method" does not supply demonstrations; he does not give any reasons, but no doubt he had in mind what we should call the theory of infinitesimals of different orders. For example, a triangular lamina may be roughly, but not exactly, replaced by a set of parallel rectangular strips; to find the centroid of the triangle we must find the *limiting* position of the centroid of the system of strips. Among other noteworthy points it may be observed that Archimedes arrived at the formula for the volume of a sphere before he discovered that for its area; and that he attributes to Democritus the discovery of the theorem that pyramids of equal bases and altitudes are of equal volume. The first proof, allowed to be rigorous, he assigns (as elsewhere) to Eudoxus. As usual, the editor's task is performed with great learning and thoroughness; his introduction in particular will be found extremely useful by those who are not familiar with Greek mathematics beyond the elementary stage.

The Central—the journal of the City and Guilds Engineering College—for August contains an article advocating the use of direct rather than alternating currents in electric traction by Mr. L. Calisch, an account of some recent improvements in vacuum evaporation by Mr. W. A. Davis, and a description of the Boncourt system of gaseous combustion by one of its inventors, Mr. C. D. McCourt. The feature of the system is the combustion of the gas and air mixture as it is passing with the requisite velocity through the interstices of a granular refractory material. A steam boiler fired in this way evaporates 16 lbs. of water per hour per square foot of heating surface. The old student notes occupy fifteen pages. Referring to work in the drawing office of a French engineering firm, Mr. K. C. Barnaby writes:—". . . there is the delightful metric system. I cannot imagine anyone who has worked and calculated in a Continental office who would not wish our antiquated system of weights and measures—well, where parallels meet."

THE fifty-seventh annual exhibition of the Royal Photographic Society, which was opened last Monday, will remain open until the 21st inst. at the Gallery of the Royal Society of British Artists, Suffolk Street, Pall Mall. In the scientific and technical sections four exhibits have been awarded medals. The first consists of examples of a new photo-mechanical process by Mr. A. E. Bawtree, who has found a method of transferring the pigment of an impression from an engraved plate, whether it is old or new, to a sheet of glass, so producing a more perfect transparency than any camera method can yield. He claims that not a grain of the pigment is lost. From this transparency copies of the original may be made by various photographic or photo-mechanical methods as is well known. He can then retransfer the pigment from the glass to paper without the loss of even the finest detail. The method of transfer is so easy that the author does not yet describe it, because it enables facsimiles of bank-notes and such documents to be prepared with a very moderate outlay for apparatus. Dr. D. H. Hutchinson's series of photomicrographs of the ova of the Mexican Axolotl show the development of the embryo from the first day after the egg has been laid up to the time of its escape from the egg. This, and Mr. Farren's series of photographs of the little egret, and Mr. G. Busby's autochrome landscape, well deserve the medals that have been awarded them. Among the numerous other exhibits we may perhaps direct special attention to the radiographs of Dr. Hall-Edwards, which show the effect of bismuth salts and iodoform in indicating details with great clearness, Dr. Thurstan Holland's "plastic" radiographs, Dr. T. W. Butcher's high-power photomicrographs, and Dr. Rodman's stereo-photomicrographs of the scales on the wings of moths and butterflies and the hairs on the leaves of plants, though it seems almost invidious to do so where so much good work is shown illustrating many different branches of work.

PARTS ii. and iii. of the Subject List of Works on Mineral Industries in the Library of the Patent Office have just been published at the office, 25 Southampton Buildings, Chancery Lane, W.C., price sixpence each. Part ii. contains classified titles of works on iron manufacture, alloys, and metallography, and part iii. those relating to metallurgy (non-ferrous and general), assaying, and fuel combustion. The lists, like others in the same series, are most helpful guides to the contents of a very valuable library.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF BROOKS'S COMET, 1911*c*.—Some excellent spectrograms of comet 1911*c* are reproduced and their special features discussed by MM. de la Baume Pluvinel and Baldet in the September number of *L'Astronomie*. The spectrographs employed were mounted at the Juvisy Observatory, and an examination of the complete series of plates shows very markedly the spectral changes which took place as the comet approached the sun; between August and the end of October a number of "unknown" radiations between λ 4100 and λ 4000 suffered a considerable diminution of intensity as compared with other radiations. The wave-lengths of these lines, considered precise to 1 Å, are 4099, 4074, 4065, 4051, 4041, 4032, and 4016. These radiations were peculiar to the nucleus of the comet, being found neither in the coma nor the tail, and as they became fainter the tail radiations became strong; it was also noted that in the later spectra the tail radiations extended well to the front of the comet's head, showing that in active comets, such as this one and Morehouse's, the tail matter is expelled in all directions. In Kiess's comet it appeared to escape from one point only. Altogether 47 monochromatic images of the nucleus were counted on the Juvisy plates, but the kathode spectrum of nitrogen was not recognised among them.

THE CORONA AT THE TOTAL SOLAR ECLIPSE OF APRIL 17.—A drawing of the corona, made by Señor J. Comas Solá, at Barco de Valdeorras (Galicia), on April 17. appears in No. 4597 of the *Astronomische Nachrichten*. Although observers at other stations were uncertain as to the definite apparition of the corona, Señor Comas Solá saw it well extended, and on his drawing depicts it extending equatorially to about $2\frac{1}{2}$ solar diameters on either side of the sun. The drawing, given principally to show the general form, represents a corona distinctly of the minimum type. The same observer also describes his spectrum observations, while many others give the results of observations of the contacts, &c.

THE DIAMETER OF NEPTUNE.—An interesting paper by Dr. G. Abetti, discussing the various measures of Neptune made since 1846, appears in No. 8, vol. i. (second series), of the *Memorie della Società degli Spettroscopisti Italiani*. He shows that the measured diameter has, in general, tended to become less as the aperture and magnification employed have increased. Using only the results from apertures of more than 40 c.m. and magnifications greater than 620, the mean values being 76 c.m. and 794 respectively, the diameter at unit distance comes out as 69·04″ for the mean aperture, and 68·98″ for the mean power; other considerations show that the true value differs but little from 69″. Using this value, he then calculates the true diameter as 5×10^4 km., the density (earth = 1) as 0·29 or (water = 1) 1·6, and the superficial gravity as 1·12, that at the earth's equator being taken as 1·0. As seen from the earth, the apparent diameter ranges between 2·39″ and 2·20″.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The University has suffered a severe loss by the death of the Vice-Chancellor, Alderman Charles Gabriel Beale, at the early age of 69. Alderman Beale, who was a graduate of Trinity College, Cambridge, was one of the most prominent citizens of Birmingham, having been elected to the mayoral chair no fewer than four times. He was mainly instrumental in carrying to a successful conclusion the great scheme for supplying the city with water from the Welsh